Dose enhancement applied to synchrotron X-ray microbeams: computational modelling and experimental validation.

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Background: Microbeam radiation therapy (MRT) is a preclinical radiotherapy technique that uses an array of parallel microbeams to deliver the dose[1]. Evidence shows that this pattern gives the same tumour control rates as conventional radiotherapy, but a much higher sparing of healthy tissues[2]. To maximize the dose deposition and increase the tumour control, MRT can be combined with dose enhancers. The aim of this study is to investigate, through simulations and experiments, whether the pattern of dose deposition created by the microbeams is preserved when dose enhancers are used. With the advent of new compact sources for MRT, which have a lower photon rate than synchrotrons [3], dose enhancement may play an important role in the transition from the experimental stage to clinical practice.

Material and Methods: The simulations were conducted with the Geant4 toolkit as in previous studies [4]. The experiment took place at the ESRF. Different energies and contrast agent concentrations have been considered (Gd 10 mg/ml and 20 mg/ml, I 10 mg/ml and 20 mg/ml). Gafchromic films have been placed at three different depths in a 4x4x6 cm^2 PMMA phantom with different compartments for the dose enhancers.

Preliminary results: Some preliminary results are shown in Fig1. The left graph shows the lateral dose at a depth of 7 mm with the microbeam patterns preserved. The right shows the depth dose profile for a 20 mg/ml Gd solution, measured along the central peak. The results show a good agreement between experiment and theory. The peak doses show good agreement. However, in some of the valley regions the calculations underestimate the actual dose compared to experiments. This needs further investigation in order to attempt to correct the modelling predictions.

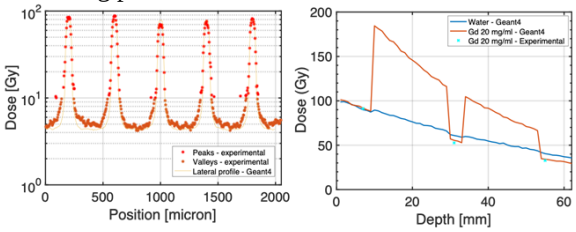

Fig.1 Lateral (left) and depth along the central peak (right) dose deposition obtained with the MRT filtered spectrum and a Gd solution (20 mg/ml) or water.

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